

July 30, 2003

Dr. Andrew Christensen, Chair  
Space Science Advisory Committee

Dear Andy,

The Structure and Evolution of the Universe Subcommittee (SEUS) met in public session at NASA Headquarters on the 1<sup>st</sup> and 2<sup>nd</sup> of July 2003. As the result of popular demand and great public interest, the presentations from the SEUS meeting are now available on the web: <http://spacescience.nasa.gov/admin/divisions/sz/SEUS0307/>. We anticipate that this website will set new standards for SScAC subcommittee meeting reports.

The first morning was a joint session with the Origins Subcommittee.

Because of the close coupling of the Origins and SEU programs, these joint sessions are extremely valuable. The joint meetings are also the appropriate venue for the reports of the Science Archive Working Group, the Astronomy and Physics Working Group, and the National Astronomy and Astrophysics Advisory Committee.

The first order of business was an Astronomy and Physics Division update from Dr. Anne Kinney, Director, Astronomy and Physics Division (A&P).

#### Major resource challenges

Dr. Kinney outlined the major resource challenges facing the division. Among the resource challenges facing the division is the cost of the delay in maintenance of the Hubble Space Telescope (HST) due to the loss of *Columbia* and the subsequent Shuttle stand-down. The HST delay cost is \$8–\$10 million per month, and the period for March through September 2003 will be covered by taking funds from the James Webb Space Telescope (JWST) program. Dr. Spergel will provide more information in his letter. Another major challenges facing A&P is the result of the most recent delays and cost increases in the Gravity Probe-B (GP-B) program. As reported during the March 2003 SScAC meeting, the GP-B spacecraft failed its thermal vacuum test in December 2002. Two reviews, a science review and a technical/risk review, by separate panels, were conducted and termination of the program was seriously considered. The decision by Dr. Edward Weiler, Associate Administrator for Space Science, was to give conditional approval for GP-B to proceed toward launch, which is now scheduled for November 2003. At the time of the July SEUS meeting the GP-B spacecraft completed another thermal vacuum test, and appeared to have passed. [I am happy to report that subsequent to the July meeting, GP-B was shipped to Vandenberg Air Force Base.] Dr. Kinney presented Dr. Weiler with a plan to cover the added costs of HST and GP-B. The additional funding needed for both missions will come in the near term from the JWST program, which is in the Origins theme. The gap in JWST funding for FY06-07 will be covered by funds from the Beyond Einstein budget in the Structure and Evolution of the

Universe (SEU) theme. The SEUS received further information the following day from Michael Salamon.

**The SEUS feels the review panels made cogent comments and the A&P Director made a proper decision in her recommendation for termination. The SEUS members regret that a consequence of the Enterprise Program Management Council (EPMC) decision is that the Beyond Einstein initiative will, in later years, be reduced to make up the replan budget for GP-B. However, the members strongly endorse the general management principle, applied in this case, of dealing with project cost problems within the theme involved.**

#### *Science highlights and Space Science Updates*

Dr. Kinney reviewed science highlights from operating missions, including the detection of a gamma-ray burst, which has been linked to a supernova, by the High Energy Transient Explorer (HETE). The Chandra spacecraft has detected activity in Stephan's Quintet and evidence of supermassive black-hole development in early galaxies. Galaxy Evolution Explorer (GALEX) science observations are beginning. Initial GALEX observations were described informally to the subcommittees during the lunch break. (Subsequent to the SEUS meeting, GALEX stopped science observations because of high-voltage spikes in the instruments. A tiger team has been formed to investigate the cause and make recommendations for safe science observations.)

Dr. Kinney reviewed the NASA Space Science Updates (SSUs) that have focused on SEU and Origins topics this fiscal year and the 8 space science launches achieved or planned from January 2003 through January 2004. The SEUS took advantage of the opportunity to attend the Space Science Update of 2 July on "Pulsar Speed Limits." In the afternoon SEUS session, Dr. Hertz reviewed the press events in the past year stemming from SEU missions. He emphasized the difference between the science selection process and the identification of newsworthy science results from missions, after their selection, development, and implementation for public affairs press releases and press events. To get media attention, the NASA release has to be simultaneous with or prior to publication or announcement elsewhere, including notices in *astro-ph*. For news releases to be effective, there must therefore be prior planning, so that the NASA announcement is not preceded by announcement in another venue. With respect to timing, these public affairs events differ in timing constraints from education and public outreach (E/PO) uses of science results.

**The SEUS strongly supports the use of SSUs as an effective mechanism to communicate important and interesting NASA-supported science results to the general public in a timely manner. In the past, the A&P Division has generally done well in its public outreach, and we in the SEUS witnessed a well composed and well scripted SSU on Pulsar Speed Limits. The SEUS recognizes that NASA has to be careful not to give the impression of "overselling" a particular science result. It would be unfortunate if SSUs are perceived by the science community as a way of circumventing the peer-review process. It is also necessary to avoid the perception that NASA missions are selected because of their potential for generating SSUs. The SEUS encourages NASA to improve the process for selecting SSUs, to be sure the process is known to the science community, and to advertise widely the opportunity of SSUs to the science community.**

### International issues

Dr. Kinney and the members of SEUS and OS discussed how instrument development projects for joint NASA/ESA missions are being affected by budget problems among the ESA member states. One consequence is that ESA is taking on management of the contributions from the 11 member nations; an approach that Dr. Kinney believes will be desirable for use on the Laser Interferometer Space Antenna (LISA) mission. Dr. Kinney reviewed the NASA Space Science budget history, the budget breakout for the five Space Science themes in the President's Budget Request for FY04, and the allocations to individual space science missions in FY03 and FY06 (planned). She finished the presentation with an overview of planning for the Beyond Einstein initiative. During the question session, SEUS and OS members discussed with Dr. Kinney NASA's role in future ESA-led missions and the impact of European budget problems on joint projects such as the Gamma-ray Large Area Space Telescope (GLAST).

### Report of the Science Archive Working Group

Dr. Joel Bregman, a member of the SEUS and Chair of the Science Archive Working Group (SAWG), reported on the April 22–23, 2003, meeting of the SAWG. The main issues discussed by the SAWG were the Celestial Navigator System (CNS), the Legacy Archive for Microwave Background Data (LAMBDA), and the Applied Information Systems Research Program (AISRP). With respect to the proposed CNS, the SAWG has made a request to the Astrophysics Data Centers Executive Committee (ADEC) to develop interoperability capabilities between NASA astrophysics data centers, as a precursor to a National Virtual Observatory, which would support the primary goals of the SEU and Origins roadmaps. Although the individual data archive programs have been working toward interoperability, funding has been lacking to achieve the objectives. The Interoperability Initiative would improve connectivity among the NASA archive centers and provide a uniform set of improved services. The SAWG thought the LAMBDA archive has a well designed website with easy data access. The one concern was with the HEALPix format used for cosmic microwave background (CMB) data sets. This format requires special software routines from the web site of the Conseil European pour la Recherche Nucleaire (CERN). The AISRP has had some successes with software, including virtual observatory tools that have been widely adopted in the archival community. However, it lacks the resources needed for the CNS initiative. The SAWG recommended that AISRP needs a better-established venue for disseminating its products, such as a journal. The questions from SEUS and OS members focused on the integration of the NASA and NSF archives. The CNS initiative would be synergistic with the NSF program and would apply the same standards. The CNS master database would cover both ground-based (NSF facilities) and space-based (NASA spacecraft) data sources. The proposal for a 3-year CNS development program would exceed the current AISRP budget. The members discussed whether research and analysis (R&A) funding in Space Science was adequate to make the Interoperability Initiative of optimal value to the science community. Dr. Kinney noted that collaboration with the California Association for Research in Astronomy (CARA) on the Keck Interferometer is going well. The full report of the SAWG is attached to this letter.

Report of the Astronomy and Physics Working Group

Dr. Kathryn Flanagan reported on the June 16–17, 2003, meeting of the Astronomy and Physics Working Group (APWG). The adequacy of the R&A budget was the issue of highest concern, particularly because R&A as a fraction of the Code S budget is declining. The APWG draft report reviews the reasons why R&A is of value to A&P and to NASA's mission. It proposes several approaches for increasing R&A resources. One of these approaches, the inclusion of R&A-related resources within new initiatives, was discussed at length by the OS and SEUS members and guests. Other topics discussed were the areas of theory that would be fundable by this approach and ways in which new areas of fundamental research can affect competition for resources among programs. Dr. Kinney and Dr. Hertz described the budget and programmatic factors that have affected the R&A budget history. Full-cost accounting could further decrease the effective R&A budget. The APWG believes the Research Opportunities in Space Science (ROSS) web site, which is the primary information source for most proposers responding to OSS NASA research announcements (NRA's), should be simpler and easier to navigate. The two subcommittees discussed ways in which the value of R&A could be communicated, both within NASA and to external decision makers. The APWG report includes concerns about the impact on the budget for balloon campaigns of the costs for constructing and upgrading the infrastructure for long-duration ballooning over Antarctica. On a positive note, the report commends the evolving responsiveness of Code R to the fundamental technology needs of Code S. Improvements include Code R NRAs that address specific Code S technology needs and the increasing fraction of Code R funding that is competed openly and selected with peer-review input. The APWG remains concerned about whether there is a coherent approach for developing new technology through the Technology Readiness Levels (TRLs) necessary to support future major science missions. The full APWG report is also attached.

**A major point of SEUS concern is the funding level for Research and Analysis (R&A), and particularly the cut in funding for theory - despite a recent Senior Review recommendation for significant increases! The SEUS recognizes that R&A plays a critical role in Code S missions, and indeed represents the "seed corn" for the ideas and technology development that give rise to future missions. The SEUS is concerned about the future R&A funding profile, and we encourage Code S to advocate for and protect the R&A program.**

Report of the Astronomy and Astrophysics Advisory Committee

Dr. Robert Gehrz, National Astronomy and Astrophysics Advisory Committee (NAAAC) Chair, briefed the SEUS and OS by telephone on the April 8-9, 2003, meeting of the NAAAC. Interim recommendations from the NAAAC have been submitted to the Office of Management and Budget (OMB). Dr. Gehrz reviewed the NAAAC charter, which was incorporated in legislation authorizing the NSF. The charter directs NAAAC to conduct assessments and make recommendations on (1) gaps and duplication between NSF and NASA in R&A programs, missions, observatories, archives, etc.; (2) coordinating the strategic plans for astronomy and astrophysics of the two agencies, and (3) advising on specific areas that may benefit from interagency coordination. The NAAAC can also conduct specialized studies, as requested by NSF and NASA. Dr.

Gehrz listed seven members who are already approved and noted that additional members were in the process of being nominated and approved. With respect to coordination between NAAAC and the Committee on Astronomy and Astrophysics (CAA) of the National Research Council (NRC), the CAA focuses on refining and promoting the strategy for the long-range plan for astronomy. The NAAAC identifies tactical approaches to pursuing the long-range plan when inter-agency coordination is involved.

The April 23, 2003, NAAAC report identifies four major ventures (science objectives) for which the NAAAC recommends an integrated (interagency) management approach. For each venture, the report cites a NASA-led project and a NSF-led project that should be coordinated. For the first science venture—understanding the formation and chemical evolution of galaxies within a billion years of the Big Bang, and understanding the formation of stars and planets—the two cited projects are the JWST and NSF's Giant Segmented Mirror Telescope (GSMT). For determining the nature of the dark energy and dark matter in the universe, the cited projects are NSF's Large-aperture Synoptic Survey Telescope (LSST) and a complementary orbiting observatory. The report describes ways in which NASA could collaborate on LSST. The third theme—probing the temporal and structural development of solar magnetic fields and activity through contemporaneous observations—cites NASA's Solar Dynamics Observatory (SDO) and NSF's Advanced Technology Solar Telescope (ATST), although the report notes that contemporaneous observations will require accelerating the ATST program. For investigations of the CMB to detect the signature of inflation (following the Big Bang), the cited projects are NASA's Wilkinson Microwave Anisotropy Probe (WMAP), ground-based microwave telescopes at several sites, and payloads in the Long-Duration Balloon (LDB) program. To provide the technical infrastructure necessary for these four major ventures, the NAAAC report cites the National Virtual Observatory (NVO), as well as support for instrument development, computing, laboratory measurements, and R&A. It notes that archiving systems for data from ground-based sources lags far behind such systems for space-based sources. In discussing challenges to NASA–NSF collaboration, the report recommends that the agencies find opportunities where relaxation of the traditional separation between ground-based and space-based astronomy will benefit broader scientific goals.

**The SEUS is concerned about the limited membership scope of the National Astronomy and Astrophysics Advisory Committee (NAAAC). As presently constituted, it emphasizes optical and near-infrared astronomy at the expense of other disciplines of interest to NASA. SEUS is worried that the first NAAAC recommendations focus on a few specific implementations and techniques rather than on broad science goals. Specifically, the Beyond Einstein initiative and the SEU roadmap are driven by science that emphasizes gravitational and high-energy astrophysics as well as theory; these areas have significant potential for interagency cooperation, but do not appear in the initial NAAAC recommendations. We urge the NAAAC to consider a broader range of collaborative options, such as between NASA's high-energy astrophysics programs and the particle/high-energy physics disciplines within NSF and the Department of Energy. Since NASA still has the opportunity to fill two slots on the NAAAC, we also urge NASA to consider the breadth of observational and theoretical disciplines that are represented, in making these final two appointments. The SEUS views with concern the NAAAC statement**

**about relaxation of the traditional ground/space separation. Since we do not expect the NSF to start a space program, this seems to be a call for NASA to engage in ground-based astronomy, inconsistent with the primary recommendation of the 2001 National Academy Study "U.S. Astronomy and Astrophysics: Managing an Integrated Program." [This recommendation reads "The National Science Foundation's astronomy and astrophysics responsibilities should not be transferred to NASA."] Any ground/space collaborations should strongly contribute to goals that are part of NASA's scientific portfolio; we recommend that NASA continue to engage in such collaborative programs in a cautious way, only insofar as they contribute directly to achievement of both the NASA strategic plan and the SEU and Origins roadmaps. Finally, we note that long-term collaborative programs may provide excellent opportunities for training students in techniques that are applicable in a variety of disciplines.**

The afternoon session of Tuesday July 1 was a public meeting of the SEUS.

*Theme scientist report*

Dr. Paul Hertz, SEU Theme Scientist, expanded on the SEU portions of Dr. Kinney's A&P update. All SEU operating missions have a stoplight status indicator of green. With respect to missions still in development, the status of Swift is yellow because of ongoing work on the telescope, integration and test of the wiring harness, and a shift of scheduled launch from December 2003 to January 15, 2004. For Astro-E2, a mission led by Japan's Institute of Space and Astronautical Science, NASA is providing an x-ray spectrometer and telescope mirrors. Schedule time was lost because of a Dewar leak on the x-ray spectrometer and a shake test problem with one mirror. Astro-E2 launch is now scheduled for February 2005. Dr. Hertz noted the status of GP-B (as noted above) and SPIDR (more on SPIDR below). The program status for GLAST is yellow because of the withdrawal of the French space agency, Centre National d'Etudes Spatiales (CNES), from support for the large telescope calorimeter. This support will be provided now by NASA and the Department of Energy (DOE), but schedule time will be lost and project costs will exceed plan. The dollar cost of the CNES withdrawal on GLAST is about \$5 million for the work to be picked up and \$5 million for the schedule slip. The NASA portions of the Herschel and Planck missions are green, but these ESA-led missions are facing problems in instrument development by European countries with budget problems. SEUS members discussed changes in mission funding approach and integration/test processes being considered by ESA to decrease the program risks in the current mission planning approach. The Extreme Universe Space Observatory (EUSO) is a large Fresnel telescope to detect cosmic rays beyond the GZK cutoff. It will fly on the International Space Station (ISS), and NASA recently selected a proposal to supply the optics for EUSO as a NASA Explorer mission of opportunity, as part of the recent Medium-class Explorer (MIDEX) competition. ESA is still in the decision process on whether to proceed with EUSO.

Dr. Hertz reported that the management reviews of the technology readiness and implementation plans (TRIPs) for the LISA and Constellation X (Con-X) missions have been completed. Developmental budgets for both missions are in the President's Budget Request for FY04. A Beyond Einstein Program Office (BEPO) will be established at

Goddard Space Flight Center (GSFC) this summer to manage both LISA and Con-X, beginning with Phase A. The LISA TRIP covered the entire project, which is a joint NASA–ESA collaboration, not just the NASA portions. The ESA’s second Small Mission for Advanced Research in Technology (SMART-2) will be used as a demonstration flight for LISA technology, with side-by-side testing of two gravity measurement packages. The formulation review panel for the LISA TRIP concluded that the SMART-2 flight is critical for proceeding to LISA implementation. Although the implementation panel’s evaluation of the LISA TRIP noted concerns about the short time for SMART-2 results to influence the LISA design and the modest schedule reserves in some areas, the panel cited the integrated modeling approach, systems engineering, and overall strength of the LISA team as positive factors. The conclusions from the TRIP review panel for Con-X were also presented and discussed. In response to a question, Dr. Hertz said that a preliminary decision to schedule LISA as the first Beyond Einstein mission was made before the TRIP evaluation reports were received.

Dr. Hertz reported that Mission concept proposals have been received for the Einstein Probes. Proposals were received for all of the concept options in the announcement. Although any mission concept studies for the Dark Energy probe will be funded by NASA grants, DOE’s Division of High Energy Physics will be an informal partner in the review of the dark energy probe mission concept proposals, as preparation for a possible joint NASA-DOE mission on dark energy. The President’s Budget Request for FY04 does not include funding for Einstein Probes before FY07. Both NASA and DOE want to begin work on Einstein Probes before FY07. The SEUS and Dr. Hertz discussed issues in partnering with DOE on a dark energy mission, including differences in management culture and in selection and funding practices.

#### *SPIDR termination*

Dr. Hertz then briefed the SEUS on the termination in April of the Spectroscopy and Photometry of Intergalactic Medium (IGM) Diffuse Radiation (SPIDR) mission. He reviewed the process by which this project was selected as a SMEX mission. Concerns over details of the data analysis technique were raised during the down-select evaluation in June 2002. An independent assessment panel was convened in October 2002 and delivered its report in February 2003. The validity of the SPIDR technique was confirmed, but an error was found in the calculation of sensitivity (signal-to-noise ratio). Simulation results were consistent with the expectations of the assessment panel. A headquarters review on April 22 led to a recommendation to terminate. The review panel found that the appropriate way to determine the best opportunity for addressing the science objectives generally related to the original SPIDR objectives is through a recompetition by all interested parties. Dr. Weiler made the final decision, and the termination letter was sent to Boston University and GSFC on May 20.

**The termination of the SPIDR SMEX program was highly unfortunate but appears to have been handled effectively and fairly. The Explorer Program office deserves credit for uncovering a subtle issue, exploring it in the required depth, and making the difficult decision to terminate the project even after the Stage 2 downselect. It is certainly troubling that a significant mistake in the sensitivity calculation was realized at such a late date, and it is unfortunate that other excellent proposals may have been unfairly treated as a result. Nevertheless, we recognize**

**that mistakes happen. It is not completely clear that the process needs to be modified in any major way, but there may still be some lessons to be learned. In particular, it may be difficult to uncover subtle scientific feasibility issues at the initial proposal level, when a large number of brief page-limited proposals must be reviewed in a short period of time. At the Phase A study level, though, the present procedure is to review technical, management, and cost risk and feasibility in great detail, with relatively less emphasis placed on scientific feasibility. The science members of the last SMEX Phase A panels in fact effectively served in the dual roles of science reviewers and advocates for a particular experiment. The addition of a few additional scientists to review the scientific feasibility of ALL the Phase-A projects might be useful.**

#### Interagency cooperation

The SEUS next heard a series of presentations about the Interagency Working Group of the National Science and Technology Council (NSTC) on the Physics of the Universe. This NSTC group was set up to respond to the NRC's *From Quarks to the Cosmos* report. Dr. Patrick Looney, Assistant Director for Physical Science and Engineering in the Office of Science and Technology Policy (OSTP), discussed the connections between OSTP physical science policy priorities and the SEU theme. He noted changes in the environment for large-scale science program investments and some "rules of engagement," which agencies are encouraged to consider in their budgets and program planning. This administration is placing greater emphasis on understanding what the nation will get from an R&D investment, minimizing redundancy, and maximizing the return on the existing investment base. Another OSTP concern is coordinating the advice received from the many federal advisory committees and NAS/NRC committees with overlapping recommendations. Dr. Looney reviewed important elements of a recent memo from OSTP and OMB on science-related priorities. With respect to how this environment affects SEU, it is important that the budget rationale for space science missions argue convincingly from the science drivers for each mission, making clear why the mission is important and why it is timely to do it when proposed. The big-ticket priorities for the administration are (in priority order) R&D for homeland and nation security, nanotechnology, networking and information technology R&D, molecular-level understanding of life processes, and environment and energy. SEUS members discussed with Dr. Looney how the NVO initiative could fit under the third priority.

The report of the interagency working group, which should be available by the end of July, will reflect elements of the President's Management Agenda, including relevance, quality, and performance as R&D investment criteria; prioritization; and coordination of investments. Dr. Looney referred to the report, *U.S. Astronomy and Physics: Managing an Integrated Program*, from the NRC's Committee on Organization and Management of Research in Astronomy and Astrophysics (COMRAA), which led to the formation of NAAAC. Because of NAAAC's legislative charter, it is an important avenue for interaction with the House Science Committee. When asked if OSTP would provide leadership on issues reflecting differences in agency cultures and strategic plans, Dr. Looney said that the "steward agency" in a given field will be expected to take the lead, not OSTP.



**SEUS members again noted areas of high-energy astronomy that are not yet reflected in the NAAAC membership or the latest NAAAC interim report.**

The first day ended with the ever-popular annual SEUS-GPRA metricfest.

And the evening and the morning were the first day.

The second day also began with a joint session with the Origins Subcommittee.

The joint session with the OS involved two issues: 1) The Explorer Program, and 2) a Code-R technology report.

### *The Explorer Program*

Dr. Hertz, in his role as Explorer Program Scientist, briefed the OS and SEUS on plans and options for the program. Dr. Hertz reviewed the three current Explorer classes, the history of changes in their cost caps, and how the cost caps are set. The costs of the expendable launch vehicles (ELVs) typically used for SMEX and MINDEX missions were discussed. The bottom line with respect to the cost cap history is that accomplishing the same science on a mission has required increasing the cost caps on both classes, as programmatic requirements have increased. The two most recent SMEX projects have had problems staying within their caps without descoping the mission science. Because the total size of the Explorer Program is relatively constant and likely to remain at current levels, increasing a cost cap decreases the flight rate for that class. The Explorer missions now in development include three MINDEX missions (Swift, THEMIS, and WISE), one SMEX mission (AIM) and four missions of opportunity (CINDI, TWINS, Astro-E2, and EUSO). The members asked about the quality of SMEX proposals, particularly the number of category 1 proposals (rated as compelling science). Launch vehicle options were discussed, including use of the Shuttle or launching a SMEX spacecraft as a secondary on the ELV for another mission. Dr. Hertz listed the reasons for a programmatic adjustment in the SMEX cap as part of the 2003 Announcement of Opportunity (AO). He concluded with the three Explorer Program options that the SScAC will be considering: (1) one MINDEX and two SMEX missions every three years; (2) one MINDEX and one large-class mission every three years; or (3) one SMEX, one MINDEX, and one large-class mission every 3.5 years.

**The SEUS (and the OS) expressed their opinions on various possibilities for the Explorer Program. Most members of the SEUS favored the existing mix of classes (option 1 above), with a minority favoring the addition of a larger-class Explorer opportunity at the expense of fewer launches. SEUS members repeated their interest in further information about the quality of proposals submitted for the 2003 SMEX AO.**

### *Code-R technology*

Dr. Chris Moore from the Office of Aerospace Technology (Code R) spoke to the OS and SEUS about fundamental technology development for space science. He began with an overview of how the four strategic themes of the Aerospace Technology Enterprise contribute to technology development and transfer for the other NASA

enterprises, the aerospace industry, non-aerospace industry, and educators. The Mission and Science Measurement Technology (MSM) theme, which has the most direct links to OSS technology needs, comprises three major programs: Engineering for Complex Systems; Enabling Concepts and Technologies (ECT); and Computing, Information, and Communications Technology. The new strategy for technology development uses input from a newly formed Technology Executive Board, plus technology assessments, to define crosscutting technology needs. These needs are addressed through externally competed NRAs or in-house exploratory research. Once proof-of-concept integrated systems are achieved, the technology will enter a transition from Code R exploration to further development via the AOs and focused technology programs of other NASA enterprises. The exploration phase within Code R will aim at achieving TRL 3 or 4, with the transition phase achieving TRL 5 to 6. In response to a question, Dr. Moore described this strategy of getting all the way to TRL 6 during the transition phase as a new approach in Code R to bridge the technology development gap from TRL 4 to 6. He listed the technology needs and priorities identified by the new Technology Executive Board, highlighting the priorities identified for OSS.

Dr. Moore then described the current projects within the ECT Program, which he heads, with emphasis on the Advanced Measurement and Detection project and its relevance to Code S missions. Recent and ongoing technology tasks include cryogenic cooler technology, direct detectors and focal planes, superconducting components for terahertz receivers and detector arrays, and technology for the dual anamorphic reflecting telescope (DART). Among the technology assessments being conducted by the ECT Program is one for Code S, which will identify and prioritize high-payoff technologies for large telescope systems. A panel of 25 astronomers was convened to define the scientific measurement capabilities needed in the infrared and far-infrared range. A \$39 million NRA for MSM, to be issued on August 4, 2003, reflects A&P technology priorities.

**The SEUS would like to commend Code R for responding to the needs of Code S in regards to technology development for advanced optical systems, sensors, and instrumentation. We are especially pleased that Code R has provided funding for crucial Code S technology, and we look forward to increased visibility about how the proposals are competed. We commend Harley Thronson's work to facilitate interactions between Code S and Code R, and Chris Moore for detailing Code R's program in relation to Code S, notably the efforts to close the TRL 4-6 gap. We recommend that Code S pursue information technology links with Code R with the same vigor and success they pursued other links.**

The afternoon of the second day was a public session of the SEUS, devoted to a discussion of our recommendations and a close-out session with Richard Howard and Anne Kinney.

Sincerely,

Rocky Kolb, Chair,  
for the Structure and Evolution of the Universe Subcommittee

## **ADDENDUM: Report of the Astronomy and Physics Working Group**

Dear Rocky and David:

The Astronomy and Physics working group met on June 16 and 17, 2003 at NASA Headquarters. The meeting was attended by Chris Blades, Steve Boggs, Ed Cheng, Marc Devlin, Kathryn Flanagan (co-chair), Dick Miller, Douglas Richstone (chair) Steve Ritz, Eun Suk Seo, Tuck Stebbins, Wilt Sanders, Ted Snow, Erik Wilkinson and Jonas Zmuidzinas. David Weinberg was unable to attend.

As always, we are tremendously impressed with the scope and vitality of the R&A and technology programs, and the grand sweep of endeavor supported by the Code S Astronomy and Physics division. We focus here on issues where we thought some improvement should be sought and might be achieved.

### **Research and Analysis Program**

The APWG is very troubled by the funding trends for the Research and Analysis (R&A) program. The R&A program is a key source of the new scientific goals and technologies which ultimately lead to new mission concepts. Our view is that the R&A program represents a critical long-term investment that NASA Code S Astronomy and Physics Division (APD) must make in order to ensure its future. We did not see historical data, but the committee has the impression that R & A has declined significantly as a fraction of the Code S budget over the last 5 years.

The problem is particularly acute for The Astrophysical Theory Program which was slated for significant increases on the basis of a very high ranking in a senior review two years ago. Instead, it has declined significantly, although some theoretical work will be supported in the Beyond Einstein Foundation Science line.

This problem appears to be caused outside of Code S, and even outside NASA. We believe that the community needs to do a better job of explaining to OMB, OSTP and the NASA Administrator that:

1. R&A is the fuel that powers the scientific community (beyond NASA centers and contractors) to utilize the great observatories and facility class instruments to do great science,
2. The scientific activities funded through the R&A program, through data analysis and theory, play a critical role in setting the agenda for future missions, and
3. The technology development funded through SR&T is the seed corn for future missions.

We discussed several possible ways to try to do better in this area in the future. Three that might work (which have certainly occurred to others) are working harder to get R&A into the next agency-wide strategic plan, including theory and R&A in each mission, and taxing the entire Code S budget at a fixed fraction for R&A as though it were infrastructure.

### Group Theory Proposals

As discussed above APWG is concerned about the declining support for R&A, especially theory. Because of the decline in support for the theory program, the group proposals constitute large quanta that absorb very large fractions of the program and which are hard to review in a competition with the individual proposals. APWG believes that any special consideration for group proposals should be eliminated and they should not be specifically encouraged (or discouraged).

### Balloons

The APWG reiterates its view that the Balloon Program should receive adequate funding to maintain its viability, both for current operations as well as for the development of future payloads. The APWG recognizes that the unanticipated requirement for NASA to build and upgrade long duration balloon (LDB) facilities in Antarctica imposes a significant burden. While improvements in these facilities are welcome, we are concerned that the associated reduction in the number of flight opportunities, required to release funds for these activities, will cause serious problems. The near term science output of the affected groups will be reduced. Delays could cause some missions to have significantly reduced scientific impact or to lose relevance entirely. The process of deciding which flights to delay should be clearly defined, and the resulting prioritization of flights should be peer-reviewed to ensure the optimization of scientific return. An additional effect of stretching out the balloon program is that the start of new payloads may well be delayed, adversely affecting NASA's longer term (2005-2009) flight program. The APWG encourages NASA to secure additional funds to reduce the ripple effect of this significant, albeit temporary, reduction in balloon flight capacity.

### Technology Priorities

The Committee is keenly interested in the interactions between Code S and Code R as they relate to technology development supporting Space Science missions. We commend the evolving responsiveness of Code R to the needs of Code S, notably their support for mid-range Technology

Readiness Levels (TRLs of 4 to 6). This responsiveness has manifested itself in the solicitation of Code S recommendations for reviewers and in NRA's addressing Code S needs for Advanced Sensors and Instruments, Large Apertures, and Ultra-Low Power Electronics. We are delighted with the increasing fraction of the Code R funding in technology that is competed openly (with center and non-center proposers on an equal footing) and peer-reviewed. We are also pleased with Harley Thronson's successes in

facilitating interactions between Code S divisions and Code R. We also note the Astronomy and Physics Division's intention to co-fund technology development opportunities. We trust that these trends will continue under the next Code R management.

The Committee, however, remains concerned about the overall Code S model for technology development, and the Code R role in that model. Technology development is distributed over the R&A program, Centers, major missions, the New Millennium Program and other settings. We are concerned that we cannot readily see a cohesive plan that supports appropriate technology development through all TRLs that feeds the needs of SMEXs, MIDEXs and larger missions. Needed technology is often called out in various roadmap documents, but the path for its maturation and infusion into missions is less clear. The APWG would like to see the list of critical technologies that Code S foresees it will need in 15 years, and an explanation of the process for prioritizing technologies.

### The Mid-TRL Gap

On previous occasions we have expressed concerns about the "TRL Gap", where technologies are developed to TRL 3, which leaves them low enough so that reliance on them will kill an Explorer proposal. We were told that Code S and Code R are now both prepared to fund TRL 3 to 6 development.

### Full Cost Accounting:

The APWG is concerned about the potential effects of full cost accounting at NASA Centers on the effectiveness of the NASA R&A program.

The exact effects of the transition to full cost accounting are not clear, increasing the risk that scarce R&A funds currently going to NASA Centers will be diverted to paying for salaries and infrastructure costs that were not a part of the original budget. In addition, we see indications that the "passback" mechanism will not have budget-neutral effects. We are concerned that the funding available for critical scientific activities will be reduced.

Inefficiencies in the passback mechanism may also lead to a loss of critical technology at the Centers. Many of these technologies are essential for current and future projects. Care is required to prevent the transition from having unintended effects in this area.

### The ROSS Website

The APWG believes that the ROSS web site, which is the primary information source for most proposers, should be simpler and easier to navigate. Helpful improvements would a search function that would permit the details of any particular program to be readily found by program name or science category. Other changes may be valuable as well. The APWG suggests that NASA and the web developers consult representatives of the

astronomical community as the web site is modified. Members of our committee have offered to help in this way.

### SPIDR Cancellation

Occasionally it may be necessary for NASA to consider canceling an Explorer mission prior to that mission's confirmation review, as was recently the case with the SPIDR SMEX mission. The APWG received a detailed presentation of the events that led to the termination of SPIDR and is satisfied that the process was careful, conscientious, and fair to both the SPIDR team and to its competitors.

### The Next Meeting

The tentative date is Oct 20-21, at NASA HQ. The tentative and partial list of items to discuss is:

- 1) a history of the SR&T program, its metrics (i.e. successes/failures), a mapping of how the programs relate to each other;
- 2) a re-brief of the effects of full costing at the Centers and how that is affecting R&A;
- 3) report on the results (such as they are) for the ROSS03 solicitations with specific results for rocket and balloon research;
- 4) a list of the technologies for APD that have been prioritized for support for development either from within Code S or from Code R.

Sincerely yours,

Douglas Richstone  
for the APWG

## **Addendum: Report of the Science Archive Working Group**

Dear Rocky and David,

The SAWG held their third meeting on April 22-23, 2003 at NASA HQ, with the following members present: Julian Borrill, Joel Bregman (Chair), Roger Brissenden, Damian Christian, Menas Kafatos, Carol Lonsdale, Bill Oegerle (Deputy Chair), Tom McGlynn, Sally Oey, Rick White, and Jonathan Borden, along with the NASA HQ personnel Paul Hertz, Jeff Hayes, Alan Smale, and Joe Bredekamp.

### **The ADEC, and Virtual Observatory Activities**

At our October 2002 meeting, the SAWG requested a white paper from the ADEC in which they describe a plan for improving connectivity and services between the archive centers. The motivation for this was that the SAWG believed that NASA science would benefit considerably from this effort, and that the archive centers were in an excellent position to begin work in this direction. We also believed that it was important to begin this work while the NSF-sponsored ITR VO (Virtual Observatory) program was in progress, as we expect synergy between the NSF and NASA efforts, which would likely save NASA time and resources. The wording of our request was:

“the SAWG suggests that it is an appropriate time for the archival centers to increase their interoperability in order to meet strategic goals and to prepare for NASA participation in the anticipated VO. In particular, this development of VO-related activities should be considered along the lines of a NASA Project that will support the primary goals of the SEUS and OS roadmaps, in concert with the data that would be collected from the envisioned missions. Project Requirements should flow from these considerations, and there should be a well-defined set of data standards, goals, milestones, staffing levels, and budgets along a three-year timetable with a nominal start date in FY04. A “white paper” would be the result of this planning. This is envisioned as a modest NASA-only program of limited scope in which the staffing and budget models should be described for both an optimum and a minimal program.”

The request from the SAWG was for a three-year, NASA-only proposal and in the six months since this request, the ADEC responded with a thoughtful and exciting proposal at relatively modest cost.

The proposal from the ADEC, entitled the *NASA Celestial Navigator System*, offers tremendous capabilities to NASA investigators. The current services offered by individual archive sites were developed in support of NASA missions with extensive input from scientists who use these data. These services are very widely used and have become invaluable for the scientific endeavor. However, there are barriers between the archive centers that prevent scientists from using these services across the archives. While the archive centers have taken modest steps to bring down these barriers, they do not have the existing resources to build the conduits between data sets housed at the various sites. Removing these barriers, consolidating databases, and providing a uniform interface lie at the center of the proposed *Celestial Navigator System*. The *Celestial Navigator* is not “The Virtual Observatory” that is all things to all people, but it is a significant and necessary step in building toward such a goal.

The SAWG endorses this proposal and believes that its execution is well within the current scope of technological abilities. Also, it leverages off the extensive experience with data,



databases, and software at the archive sites as well as the NSF-ITR effort. The management and timelines seem sensible and there is enthusiasm by the member institutions, which should help the project to succeed. We believe that it is valuable to begin this program in FY04 as it will permit the project to be carried out concurrently with the NSF-ITR (which runs through FY06), with whom they would naturally interact (many of the members of the team for *Celestial Navigator* are participants in the NSF program). This NSF effort has developed a lot of “under the hood” elements, while the proposed NASA effort is a practical realization within the virtual observatory concept.

The costs beyond the end of this program are likely to be small. The software that is developed for *Celestial Navigator* will need to be maintained, but we estimate that it is at the 5-10% level of the yearly cost of development.

## **LAMBDA**

The WMAP data were released on schedule and without problems, an impressive achievement since many members of the same team were responsible for the simultaneous release of the scientific results. These data are generally available in HEALPix format. The SAWG recognizes the emergence of the HEALPix pixelization as a de facto standard for *WMAP* and other CMB datasets. We are concerned that software enabling the analysis of data in this format should be made easily available to the community. As funds permit, *LAMBDA* should work with the developers of the HEALPix software to ensure easy community access to needed HEALPix libraries along with other software. *LAMBDA* might also explore the development of FITS WCS standards which would allow direct incorporation of HEALPix format data in FITS.

## **AISRP**

The SAWG believes that the goal of the AISRP program is an important one, the support of software development that benefits a range of NASA scientists yet is beyond the software produced by archive or data centers. This program supports areas of special expertise (e.g., wavelet analysis, CMB analysis), adventurous prototypes that may evolve into valuable new tools, and other programs. Projects that do not produce deliverables were thought to be less valuable and this should be considered in the evaluation of future proposals.

Some components that will be included in a VO effort like *Celestial Navigator* were developed within the AISRP, so this might appear to be a natural source of funding for this effort. However, current AISRP funding is extremely modest and these funds are completely inadequate to support an effort such as *Celestial Navigator*, which will require new resources.

## **Other Business**

There were a few other presentations and items that did not lead to “action items”. Arnold Rots gave a presentation of CXC activities where the ongoing activities appear to be running smoothly. They have plans to produce Level 3 products, such as point source catalogs from all archival data, which should prove to be very useful, as comparable catalogs from other X-ray telescopes (e.g., *ROSAT*) are widely used. The status of *SOFIA* was presented by Tom Greene, including instrument development, pipeline software production, and their PDMP. They

seem to be proceeding sensibly, although some details about the archive and the interface have not yet been worked out.

A detailed plan for the NASA Herschel Science Center was submitted by George Helou, but there was insufficient time to review the document prior to the meeting. There will be an ongoing discussion between committee members through email and this issue will be taken up in detail during our next meeting.

There was a brief presentation on PDMP policy by Alan Smale in which the SAWG was asked if they should review PDMPs. Such plans should be reviewed and the SAWG seems to be a reasonable group to conduct such reviews as they arise. Alan Smale, who is new to code SZ, is known to the community through his many contributions in X-ray astronomy and his appointment improves the manpower situation within MO&DA, permitting him and Jeff Hayes to provide the attention needed to a broad range of issues.

Finally, we received feedback on previous suggestions. We had been concerned about the way in which GLAST planned to make proprietary the concepts behind winning proposals rather than data. The GLAST program has modified this and there will be no proprietary period. Also, we discussed with the GALEX representative about having an early release of calibration data and they have responded positively and are also modifying their GO program.

The next meeting of the SAWG is expected to take place in October 2003 and we welcome suggestions from the SEUS and the OS for future topics to be addressed.

Sincerely yours,

Joel Bregman  
for the SAWG